SOLAR PHOTOVOLTAIC AND THERMAL SYSTEMS ACCEPTANCE REQUIREMENTS

IR 16-8

References: 2007 California Building Code (CBC), Sections 1609A and 1613A
2007 California Electrical Code (CEC), Articles 250, 310, and 609
California State Fire Marshal Photovoltaic Installation Guideline dated April 22, 2008

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Discipline: Structural, Access Compliance, Fire-Life Safety, Electrical

This Interpretation of Regulations (IR) is intended for use by the Division of the State Architect (DSA) staff, and as a resource for design professionals, to promote more uniform statewide criteria for plan review and construction inspection of projects within the jurisdiction of DSA, which include State of California public elementary and secondary schools (grades K-12), community colleges, and state-owned or state-leased essential services buildings. This IR indicates an acceptable method for achieving compliance with applicable codes and regulations, although other methods proposed by design professionals may be considered by DSA.

This IR is reviewed on a regular basis and is subject to revision at any time. Please check the DSA web site for currently effective IR's. Only IR's listed in the document at http://www.dsa.dgs.ca.gov/Pubs/default.htm (click on "DSA Interpretation of Regulations Manual") at the time of plan submittal to DSA are considered applicable.

Purpose: This Interpretation of Regulations (IR) describes the Division of the State Architect (DSA) requirements for acceptance of solar photovoltaic and solar thermal systems used in construction projects under the jurisdiction of DSA

Scope: This IR clarifies the requirements for structural support, and anchorage of panels and balance-of-system (BOS) equipment. It also addresses the basic Fire-Life Safety and some Electrical requirements of the California Building Code (CBC).

Photovoltaic roofing systems (such as tiles) that incorporate photovoltaic technology physically integrated into the roof covering materials are outside the scope of this IR.

Background: Typical photovoltaic (PV) or solar thermal systems consist of solar panels and BOS equipment. The BOS equipment includes foundations, support structures, DC-to-AC inverters, electrical wiring, electrical protection, monitoring, and safety equipment.

Photovoltaic panels are anchored to building structures. The anchoring relies on various attachment systems such as support frames (Section 3, below), ballast (Section 4, below), or adhered systems (Section 5, below).

Solar thermal panels are typically anchored by support structures.

1. DESIGN AND CONSTRUCTION OF SOLAR ENERGY SYSTEMS: DSA will not review the design and construction of the panels and the BOS equipment. However, the panels and BOS equipment must be designed and constructed to meet the requirements of Title 24.

See Sections 7 and 8 below for the requirements of Access Compliance and Fire-Life Safety, respectively.

2. REVIEW OF SOLAR PHOTOVOLTAIC AND THERMAL SYSTEMS: The Division of the State Architect Structural Safety reviews the anchorage of solar panels and their BOS equipment to the building structure or foundation. The anchorage design for solar panels and their BOS equipment must meet the wind force requirements of the CBC, Section 1609A and the seismic requirements of ASCE 7-05, Chapter 13.

Manufacturer's support frames will also be review by DSA. The building's vertical and lateral load resisting systems will also be evaluated for the additional loads from the solar panels and BOS equipment.

2.1 Projects Exempt from DSA Review:

Additions of solar energy systems to existing buildings may be exempt from DSA review when the total cost of the project (including any other construction, site work, etc.) is less than the cost limit indicated in IR A-10 for alteration projects. The cost limit is adjusted annually, from a baseline cost of $25,000 in 1999 dollars as required by Title 24, Part 1, Sections 4-308 and 4-309. The adjusted cost limit is published in IR A-10 annually.

All solar energy systems and their installation, including projects exempt from DSA review, shall meet the requirements of Title 24 and applicable provisions of this IR.

2.1.1 Exception: Regardless of costs, solar energy systems installed on or supported by free standing structures (whether standing alone or attached to existing buildings) are not exempted from DSA review. Examples of free standing structures are shade structures, lunch shelters, canopies, large arrays of panels supported on a single pole, etc.

3. PANELS SUPPORTED ON FRAMING SYSTEMS AND FOUNDATIONS:

DSA will review support frames either supplied by manufacturers or designed by the architects or structural engineers in general responsible charge (see Section 6 below), foundations, primary structure, the connection details of panels to support frames and connection details of support frames to primary structures or foundations. The design of the support frames, foundations and connections must meet the following wind and seismic requirements:

3.1 Requirements for Wind Design: The wind design requirements are given in CBC Section 1609A. The design shall consider the effects of partially enclosed structure configuration (if presented), and discontinuities at panel free edges and corners.

3.2 Requirements for Seismic Design: The seismic anchorage design requirements are given in CBC Section 1613A, and ASCE Standard 7-05, Chapter 13.

4. BALLAST PANEL SYSTEMS: Ballast panels may only be installed on a flat roof with minimal slope for drainage purposes. Panels in a ballast system are not attached to the roof. They rely on their weights and aerodynamics to counter the wind uplift forces.

4.1 Requirements for Wind Design: The panels shall be designed and installed to resist wind loads prescribed in CBC, Section 1609A. The minimum design wind force shall be a net pressure of 10 lb/ft2 acting in either direction normal to the panels per ASCE 7, Section 6.1.4.2.

Wind tunnel test reports for wind (uplift) are required to verify the design.

4.2 Requirements for Seismic Design: The panels must be seismically restrained from falling off the roof or excessive movements on the roof. Individual panels need not be restrained independently if the panels are connected with an interlocking mechanism that is capable of holding the panels together in the horizontal and vertical directions.

The overall panel array must be restrained. The restraint and panel interlocking mechanism must be designed to resist sliding and pop-up resulting from lateral and vertical seismic forces and displacements per CBC Section 1613A, and ASCE Standard 7-05, Chapter 13. The restraint and panel interlocking mechanism may be verified either through time-history non-linear dynamic analysis or shake table testing in accordance with International Code Council (ICC) Evaluation Service (ES) Acceptance Criteria AC-156.

4.2.1 Flexible utility connections, such as electrical cables, may be required to accommodate movement of the panels.

4.2.2 BOS equipment shall be anchored per CBC Section 1613A, and ASCE Standard 7-05, Chapter 13.

4.3 Other Considerations: Ballast panel systems shall not cause excessive sagging of the roof resulting in ponding. They shall also not block or impede drainage flows to any overflow drains and scuppers.

5. ADHERED PHOTOVOLTAIC PANELS: Adhered photovoltaic panels are attached to supports by adhesive. Currently, there are no building code criteria, ASTM standards, ICC evaluation criteria, or other recognized industrial standard for adhesives used to anchor solar panels. Adhered photovoltaic panels may be accepted if test and analysis data, and quality control and assurance program are submitted that demonstrate an equivalent level of safety as positive mechanical anchorage systems.

The local DSA Regional Office should be contacted early in the design phase if an adhered system is anticipated.

6. SUBMITTAL REQUIREMENTS: All projects involving installation of photovoltaic or solar thermal systems shall have a California licensed or registered architect or structural engineer in general responsible charge per Title 24, Part 1, Section 4-316. Applications for project review shall be submitted to the DSA Regional Offices, following the normal process for project submittal. An overview of the project submittal process and requirements may be found on the DSA web site. (See Appendix B for web links.)

In addition to the above requirements, the following items are also required for review:

6.1 General

6.1.1 Construction plans and specifications shall be signed and stamped by architect or structural engineer in general responsible charge per IR A-19. The architect or structural engineer in general responsible may use construction plans and specifications prepared by the manufacturer's California registered engineer provided the requirements of IR A-18 are met.

6.1.2 The plans and specifications shall including anchorage or restraint details of the panels, BOS equipment, support structures, and foundations. Also submit any applicable anchorage calculations.

6.1.3 Shop drawings or fabrication and installation drawings of the system.

6.1.4 Calculations to verify that the primary structure will support the additional vertical and lateral loads from the panels and BOS equipment. Also provide calculations verifying that roof deflection will not cause ponding.

6.1.5 Roof Live Loads on Panels. It is not necessary to include roof live load (20 psf) in the area(s) covered by the panels when these area(s) are inaccessible, or fenced off with posted signs prohibiting storage under the panels.

When applicable, include snow loads and loads from snow drift.

6.2 Ballast Panel Systems

6.2.1 Wind tunnel test reports that address wind uplift per Section 4.1.2 above. Listings or evaluation reports issued by ICC Evaluation Services, Dade County, or other recognized testing and evaluation organizations per IR A-5 may be substituted for wind tunnel test reports if the listings or evaluation reports were issued on the basis of wind tunnel testing.

6.2.2 Provide Panel Interlocking system verification using either a time-history non-linear dynamic analysis or shake table testing in accordance with ICC ES Acceptance Criteria AC-15-6, per Section 4.2 above.

7. ACCESS COMPLIANCE: Projects which consist only of solar energy system work installed on existing buildings do not trigger accessibility code requirements or DSA accessibility review. See Section 1134B.2.1, Exception 4, Part 2, Title 24, CCR, for detailed requirements. Also see DSA IR 11B-6, Mechanical Only Projects Exempt from Accessibility Review.

8. FIRE-LIFE SAFETY: The installation of solar or thermal systems will be reviewed for code compliance by adherence to the *State Fire Marshal Solar Photovoltaic Installation Guideline* in all respects including any additional amendments, supplements, or official interpretations. Other proposed means of achieving compliance will be considered and evaluated.

8.1 Fire-Life Safety Review: Photovoltaic and thermal stand alone systems that have support structures of combustible materials shall be located per CBC requirements and may not be located in Frontage areas used for adjacent building area increases. Noncombustible support structures and BOS equipment may be located next to adjacent buildings provided exiting is maintained and are not required to have automatic fire sprinkler system coverage where the configuration of the system will not allow heat, smoke or gasses to be trapped. Noncombustible stand alone systems need not be included in the basic area calculations.

8.2 Requirements for Fire-Life Safety Design: When panels are supported on framing systems and foundations, they shall be of non-combustible materials and shall be designed so that heat, smoke and other gasses can not be trapped under the panels. Framing systems may not be placed in designated fire access lanes. Combustible framing systems may not be placed within the 2007 CBC "Frontage Increase" areas of buildings constructed under the 2007 CBC, nor within the required side yard areas for existing buildings constructed under previous codes, without prior approval of DSA Fire-Life Safety.

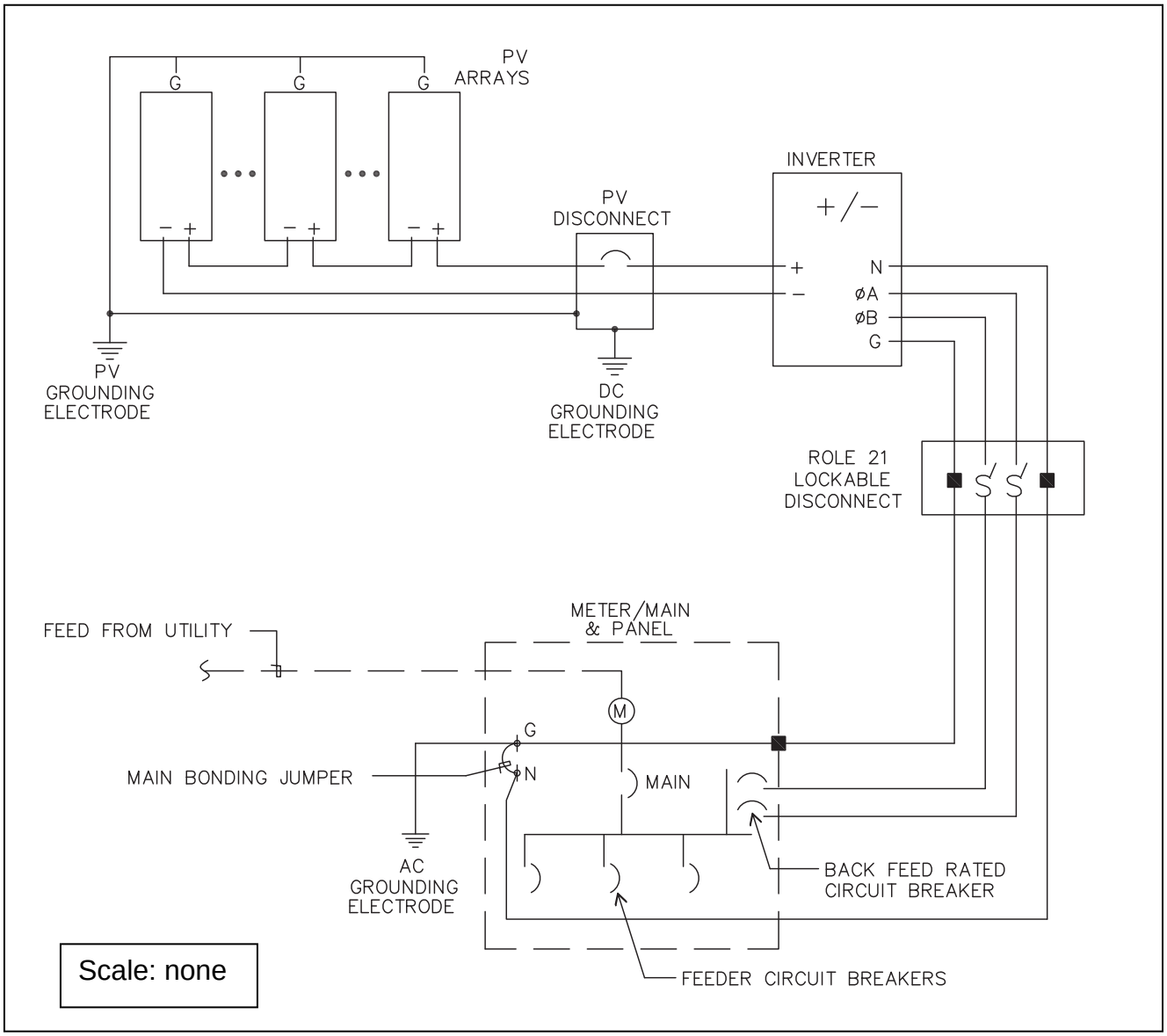
9. ELECTRICAL REQUIREMENTS: Solar energy systems shall meet the requirements of the 2007 California Electrical Code (CEC). All systems shall be grounded in accordance with the 2007 CEC, Article 250. Electrical cables and materials shall meet the criteria for weather proof locations per the 2007 CEC, Article 310. Solar photovoltaic systems shall comply with the requirements of 2007 CEC, Article 690. Appendix A shows an example of a PV system grounding.

Appendices:

Appendix A – Example of PV System Grounding

Appendix B – Hyperlinks to Web Pages

Appendix A: Example of PV System Grounding



Appendix B: Hyperlinks to Web Pages

Some of the documents referenced in this IR are available from the following web pages:

IR A-5: http://www.documents.dgs.ca.gov/dsa/pubs/IR_A-5_rev06-02-08.pdf

IR A-10: http://www.documents.dgs.ca.gov/dsa/pubs/IR_A-10_03-17-08.pdf

IR A-18: http://www.documents.dgs.ca.gov/dsa/pubs/IR_A-18_issued02-01-08.pdf

IR A-19: http://www.documents.dgs.ca.gov/dsa/pubs/IR_A-19_rev04-07-08.pdf

IR 11B-6: http://www.documents.dgs.ca.gov/dsa/pubs/IR_11B-6_02-04-08.pdf

Overview of DSA Submittal Process: http://www.dsa.dgs.ca.gov/PlanRev/overview.htm

Fire Marshall's Guidelines: http://www.osfm.fire.ca.gov/pdf/reports/solarphotovoltaicguideline.pdf